FOREST BOTANY

A Short Course for Trainees of the

W.A. Forests Department

TABLE OF CONTENTS

CHAPTER I - BOTANY AND THE FORESTER

All living matter belongs to either one of two great groups: the Animal Kingdom or the Plant Kingdom. The science which is devoted to the study of the Plant Kingdom is called Botany. As trees are important members of the Plant Kingdom, the study of Botany is a fundamental part of the study of Forestry.

The field which Botany covers is, of necessity, an immensely wide one. In order that its study may be somewhat simplified, the subject has been broken down into a number of minor fields. Some of these are:

Plant Anatomy	:	the study of the structure and morphology of plants.
Plant Taxonomy	:	the naming, identification and classification of plants.
Plant Physiology	:	the study of the way in which the plant builds and maintains its living tissue.
Plant Genetics	:	the study of the inheritance of plant characters.
Plant Ecology	:	the study of the way in which communities of plants develop, live together and influence one-another.

Although these fields have grown into distinct sciences of their own, each is related by a common bond: the plant. Thus a knowledge of one field always presupposes some knowledge of the others.

For this reason, the study of Botany is an essential part of the study of Forestry, for in many ways, the science of Forestry is another of the offshoots of the science of Botany. "Forest Botany", the term given to the study of all the biological aspects of trees, provides the link between Forestry and Botany.

THE FORESTER AND FOREST BOTANY

Foresters in the Western Australian Forests Department call upon their knowledge of Forest Botany in many of their activities. Indeed, the practice of Silviculture, which is concerned with the establishment, tending and harvesting of forest crops, requires an intimate knowledge of the manner in which different trees will regenerate and develop to maturity. Botanical knowledge is the very basis of sound silvicultural practice.

Other aspects of Forest Botany with which the forester is concerned are:

(i) The collection of plant material for herbariums, or seeds for the Departmental Seed Store.

(ii) Nursery work, involving the growing of young plants from seed and their protection from insect attack and disease.

(iii) The identification of different trees and their classification as merchantable or non-merchantable.

(iv) The planning of efficient forest utilization,which requires knowledge of the distribution and composition of different forest types.

THE FORESTER AND FOREST BOTANY (continued)

(v) Plant Breeding, a subject of increasing importance in plantation forestry.

TERMINOLOGY

An initial problem for any student confronted by a new field of study is that of terminology; there is always an alarming array of new terms which must be mastered before even a rudimentary understanding of the subject can be obtained.

This is true of Botany as it is of all sciences, and there is no easy way out of it. It is suggested that each student compiles his own glossary of new terms as he comes across them. These can then be learnt by constant reference and periodic self-testing.

To assist the student in this regard a short glossary of common botanical terms may be found as an Appendix (page 34) to these notes.

THE SCOPE OF THIS COURSE

The aim of this short course is not to create botanists, but rather to provide young foresters with both an appreciation of the scope of Botany and with sufficient botanical knowledge to enable them to (i) cope with certain aspects of their work and (ii) progress to further studies in the over-all field of forestry knowledge.

The work presented here is therefore essentially introductory in nature; however, a list of suggested Further Reading has been included as an Appendix (page 32) and the interested student can follow up any points in this course through the publications listed therein.

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CHAPTER II - ANATOMY

- THE STRUCTURE AND MORPHOLOGY OF PLANTS -

The subject of Anatomy deals with the structure of plants and for our purposes can be separated into two parts:

(a) The microscopic structure, which can only be seen with the aid of a microscope, and

(b) The macroscopic structure, which can be seen with the naked eye.

These will be dealt with separately in the lectures which follow.

Note: It will be necessary in these lectures to introduce many new terms. The reader must make a conscious effort to learn the meanings of these terms and to familiarise himself with their use.

MICROSCOPIC ANATOMY - THE PLANT CELL

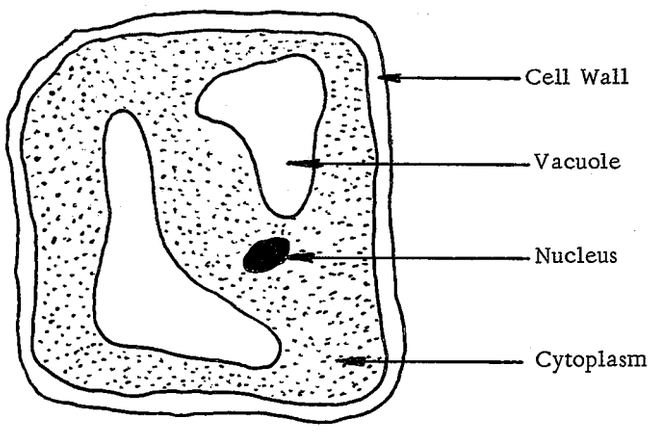
The Cell: The Cell is the basic structural and functional unit of all living matter, both plant and animal. The cell is basic to living matter in the same way that the brick is basic to the brick house: as a house is made up of a complex organisation of single bricks, so a plant is composed of a complex organisation of single cells.

The cell is thus the logical starting point for a study of the anatomy of the plant.

Plant cells vary tremendously in size, shape and function, but all have certain characteristics in common and these will now be examined.

Cell Size: Cells are generally so tiny that they cannot be seen without the aid of a magnifying glass or a microscope, but once again, variation occurs. Examples of the larger cells are the vessel cells (or "pores") which can be seen in the cross-section of a piece of Hickory or Wandoo timber; examples of the smaller ones are the cells of the root tip, one hundred million of which, if closely packed, would fit in a volume of one cubic centimeter.

Cell Structure: The parts of a "typical" living cell may be seen in the accompanying diagram. They are: (i) the cell wall; (ii) the cytoplasm; (iii) the vacuole and (iv) the nucleus.



MICROSCOPIC ANATOMY - THE PLANT CELL (continued)

(i) The Cell Wall: Each plant cell is surrounded by a cell wall. The thickness of this wall varies considerably, even in cells of the same type in the same plant. The main function of the cell wall is to provide mechanical support for plant tissues. (Animals, on the other hand, which have a skeleton of bones to support their tissues, have very thin, delicate, membrane-like cell walls which perform no supporting function.)

The cell wall is composed mainly of complex substances called cellulose and lignin. Without lignin, the tree could not exist (most other plants have little or no lignin). If we again think of the cells as the "bricks" of the plant, then lignin is the "mortar" which holds the tree cells together.

(ii) The Cytoplasm: This is the living material of the cell and contains the nucleus. The cytoplasm and the nucleus are together called the protoplasm, and it is within the protoplasm that all the processes responsible for life and growth are carried out.

(iii) The Vacuole: Also confined within the cell walls are the vacuoles, which contain a fluid called the cell sap. The cell sap consists of the food reserves and waste products resulting from the processes which are carried out in the cytoplasm.

Later in the course we will learn about the vital life processes of the plant (called Photosynthesis and Respiration). It will then be important to remember the location of these processes in the cell.

THE MERISTEMATIC REGIONS - PLANT GROWTH

It is common knowledge that the roots of a plant grow downwards, the shoots grow upwards and the stem grows outwards. This growth is brought about by growth of the plant tissues and occurs in two ways: (i) by an increase in the size of existing cells; and (ii) by an increase in the number of cells, brought about by the division of existing cells to form new cells.

Cells in any part of the plant are capable of increasing in size as the plant tissue matures, but Cell Division, the process whereby new cells are formed, occurs only in specialised regions of the plant. These are called the Meristematic Regions.

There are three meristematic regions:

(a) Root Meristem: occurs at the tip of each root and is responsible for increasing the length of the roots.

(b) Shoot Meristem: occurs at the tip of each shoot and is responsible for increasing the length of the shoot.

(c) Cambial Meristem (or "Cambium"): occurs in a sheath around the circumference of the stem, shoots and roots, and is responsible for the increase in diametric growth, or girth.

(The Shoot and Root Meristems are both referred to as "Apical" Meristems.)

THE MERISTEMATIC REGIONS - PLANT GROWTH (continued)

The mechanism of cell division is too complex to be studied in this course, but it is as well to remember that it is a delicate process and damage to the meristematic regions of a plant should always be avoided.

MACROSCOPIC ANATOMY - PLANT MORPHOLOGY

Having studied the individual cell and the way in which cells multiply to provide plant tissues, the plant as a whole may now be discussed.

All plants have their cells organised into the same basic parts. These are:

(a) the roots;

(b) the stem;

(c) the leaves;

(d) the reproductive organs.

(a) The Roots:

Function: The roots, which comprise the underground portion of the plant, have two main functions: (i) to anchor the plant firmly in the ground and thus enable it to resist the forces of erosion and wind; and (ii) to seek and absorb moisture and mineral nutrients from the soil and pass these nutrients on to the stem and leaves.

Root Systems: The root systems of various plants vary greatly in their development. These differences are governed by the type of plant involved and by the nature of the soil in which the plant is growing. Generally three types of root system can be found: (i) the tap root system, (ii) the fibrous root system and (iii) systems which are a mixture of both tap and fibrous root systems.

The tap root system consists of a large root shaped like a massive carrot, which pushes down deep into the soil. Small feeder roots extend from the side of this tap root.

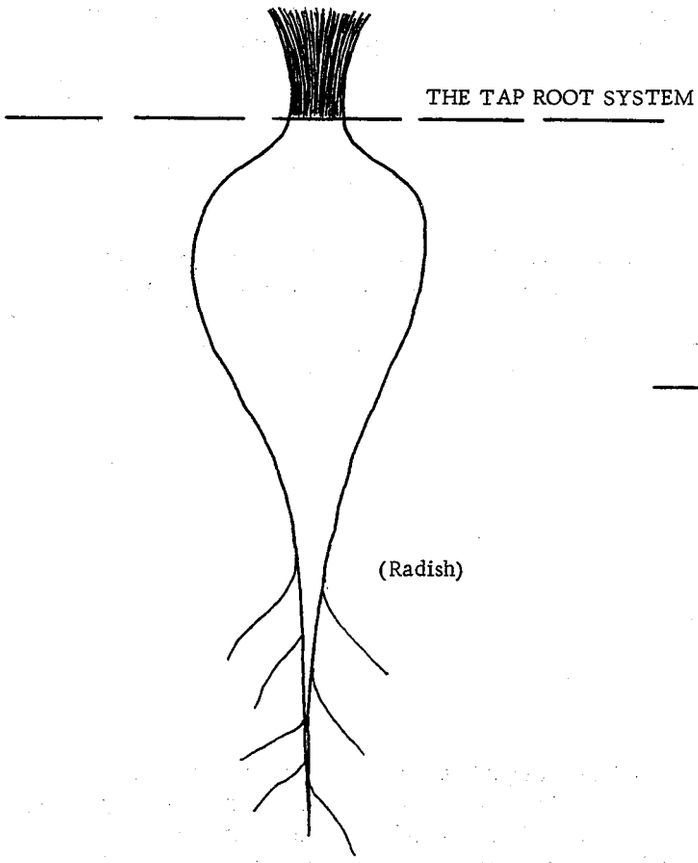
This system is generally found in plants growing on deep, well drained soils.

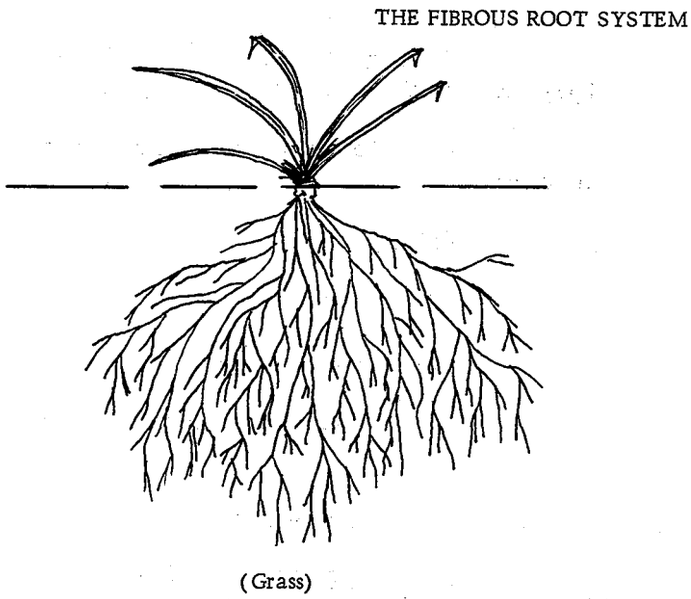
The fibrous root system is characterised by a shallow root development spread over a wide area and consisting of a great number of branching roots all of a similar size.

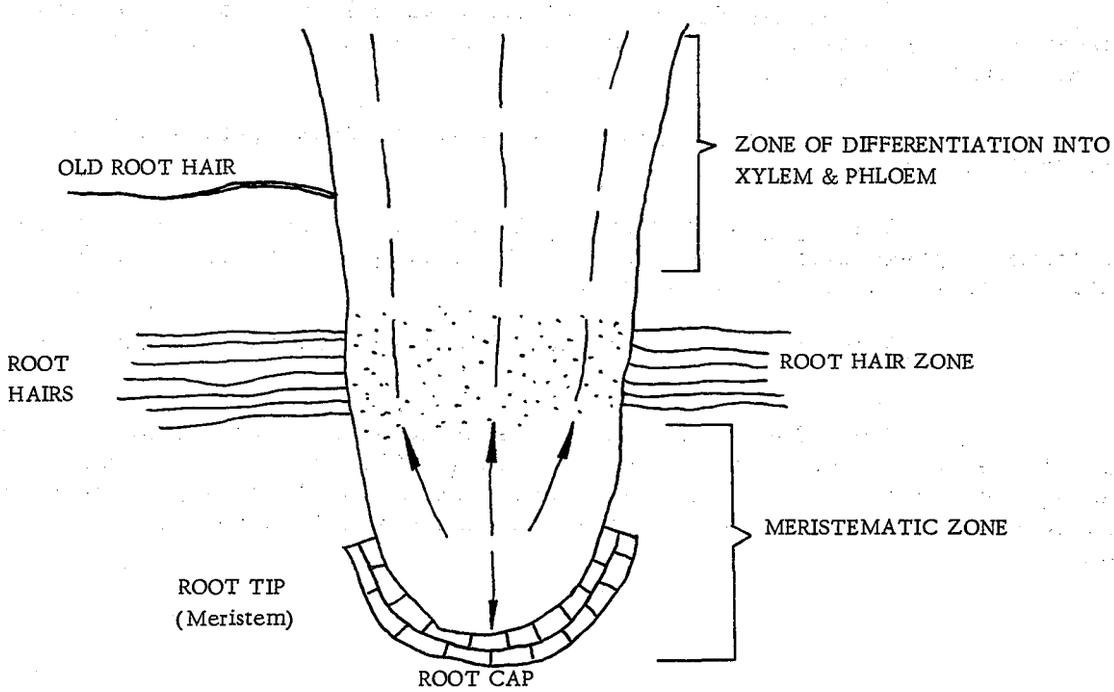
Diagrams of the tap and fibrous root systems appear on page 6.

Many plants, and most forest trees, have root systems which are intermediate between the above two types. The tree has a fibrous, feeding root system near the surface layers of the soil and tap roots going deep down into the soil to enable them to find water in times of summer drought.

ROOT SYSTEMS:







MACROSCOPIC ANATOMY - PLANT MORPHOLOGY (continued)

(a) The Roots (continued)

Root Structure: Within a branching root system, the function of the root depends upon its age. The older roots function only as support for the aerial portion of the plant, and as a "pipeline" for nutrient solutions; the young roots carry the fine feeding rootlets responsible for the absorption of the soil water and minerals.

On each of the fine rootlets may be found the following parts:

1. The root hairs: These fine, thread-like organs perform the absorption process. With age, the root hairs develop into rootlets and then roots. They occur in a "Root Hair Zone" immediately above the root tip.

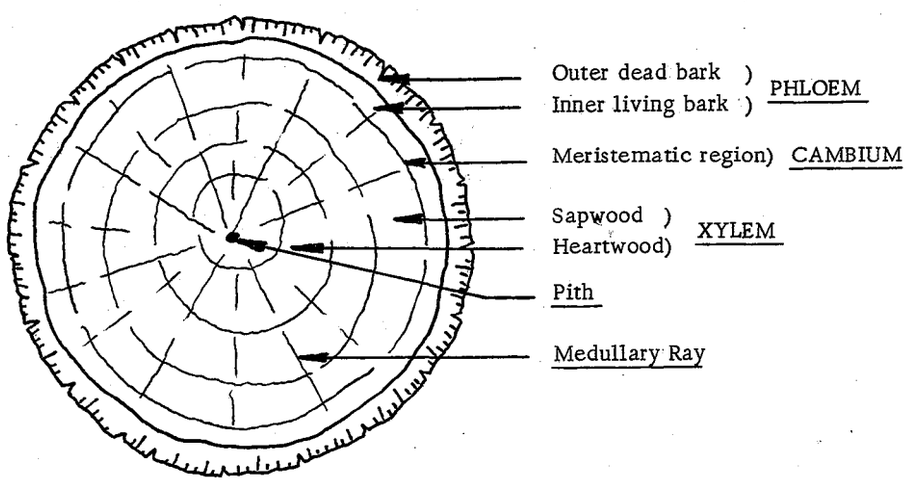
2. The root tip: This is the meristematic region of cell growth by cell division and expansion.

3. The root cap: This is a thick layer of large cells whose job is to protect the delicate root tip as it pushes through the soil.

(b) The Stem

Function: The stem of the plant has three important functions to perform. These are: (i) to support the leaves and crown of a plant, allowing them access to the air and the sunlight; (ii) to conduct water and minerals absorbed by the roots up to the leaves where they are converted into plant food; and (iii) to conduct these food materials from the leaves down to any part of the plant which requires them.

Structure of the Stem: The stem of the plant is composed of several different tissues, the presence of which enables the stem to carry out the functions mentioned above. The cross-section of a tree bole illustrates where these different tissues occur:



MACROSCOPIC ANATOMY - PLANT MORPHOLOGY (continued)

(b) The Stem (continued)

(i) The outer dead bark: consists of old dead phloem tissue. Its function is the protection of the inner living cells and the cambium.

(ii) The living bark: consists of live phloem tissue. These cells are responsible for the conduction of the food materials formed in the leaves back to the remainder of the plant.

(iii) The cambium: consists of a narrow band of tissue which is responsible for the outward growth of the stem. As the plant grows, the cambium produces phloem tissue to the outside, and xylem tissue to the inside.

(iv) The sapwood: this is living xylem tissue, whose function is the conduction of the water and nutrients from the soil up to the leaves.

(v) Heartwood: This is dead xylem tissue (old sapwood) in which the vacuoles of the cells may become filled with gums and resins. Such cells cannot conduct nutrient solutions, but are very strong and provide mechanical support for the stem.

Note: The distinction between heartwood and sapwood is only apparent in long-lived woody stems such as those of trees.

(vi) The pith: the central core of the stem resulting from the original juvenile growth of the plant.

(vii) Medullary Ray: unlike the xylem and phloem tissue which runs vertically up and down the axis of the plant stem, the medullary rays run across the stem. They appear as thin, radial lines across the cross-section of a tree trunk. The function of the medullary rays is the radial transport of food materials (in the sapwood) and food storage (in the heartwood).

Note: When the growth rate of the cambium varies with the seasons, alternate bands of dark and light coloured wood are formed in the heartwood by this varied growth rate. These circular bands are called Growth Rings. When one growth ring is formed each year (as is normally the case), they can be referred to as Annual Rings. Annual rings show out more distinctly in some species (for example the pines) than they do in others (Eucalypts).

(c) The Leaf

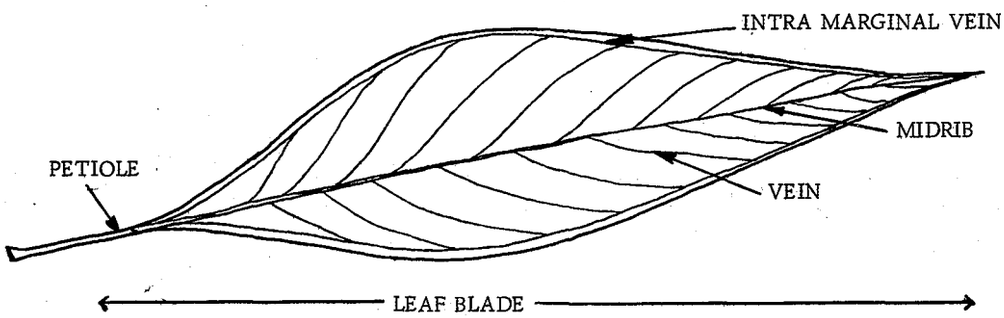
Function: although the leaves of different plants may vary greatly in appearance, they all perform the same vital functions. These are: (i) Photosynthesis, the formation of plant foods from basic nutrients; (ii) Respiration - the 'using up' of these foods to provide energy for life and growth; and (iii) Transpiration - the release of excess water, as water vapour, to the air.

MACROSCOPIC ANATOMY - PLANT MORPHOLOGY (continued)

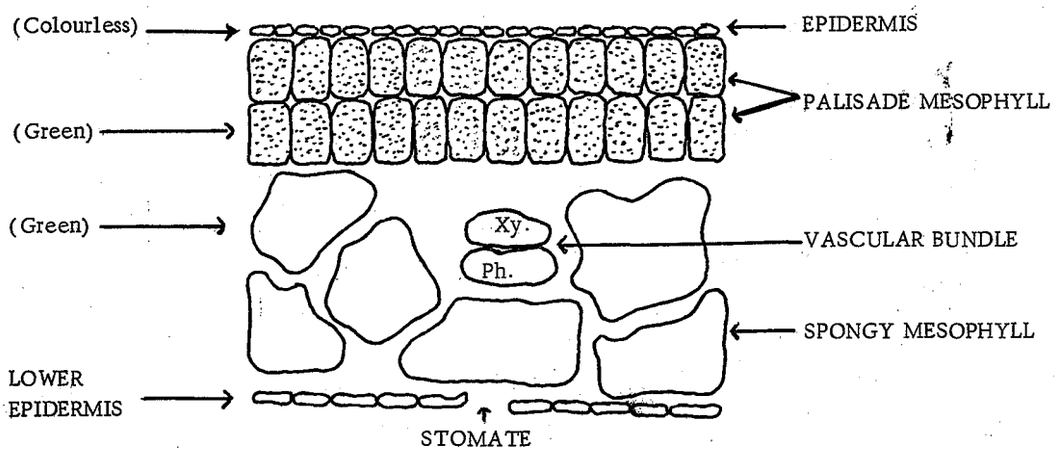
(c) The Leaf (continued)

Types of Plant Leaf: there is a tremendous variety in the sizes and shapes of plant leaves. The trees with which the forester is concerned, however, may be divided into two broad leaf groups: (i) the needle leaved trees such as the pines and Sheoak; and (ii) the broad leaved trees, such as Jarrah and Banksia.

Parts of the Leaf: the typical leaf of the broad leaved tree has the following parts: (i) the petiole (or stalk); and (ii) the leaf blade, which contains the midrib, the veins (or vascular bundles), the intramarginal vein and the leaf tip. These are illustrated in the following diagram:



Internal Structure of the Leaf: a cross section of a leaf will show the following tissues: the epidermis or skin; the mesophyll and the vascular bundles.



(i) The epidermis: this is the leaf skin. It consists usually of a single layer of cells which cover the entire leaf surface. It is a tough layer, well suited to its job of protection of the soft tissues within the leaf blade. The outer wall of each epidermal cell is thickened and covered by a thin film called Cuticle which is almost impervious to the passage of water or air.

(ii) The mesophyll tissue: this consists of two types of cell tissue: (i) the Palisade Mesophyll which are large upright cells performing a supporting function; and (ii) the Spongy Mesophyll tissue, an open meshwork of large cells which contain chlorophyll.

MACROSCOPIC ANATOMY - PLANT MORPHOLOGY (continued)

(c) The Leaf (continued)

(iii) The vascular bundles: these are bundles of xylem and phloem tissue whose function it is to carry the nutrient and food solutions to and from the mesophyll tissue.

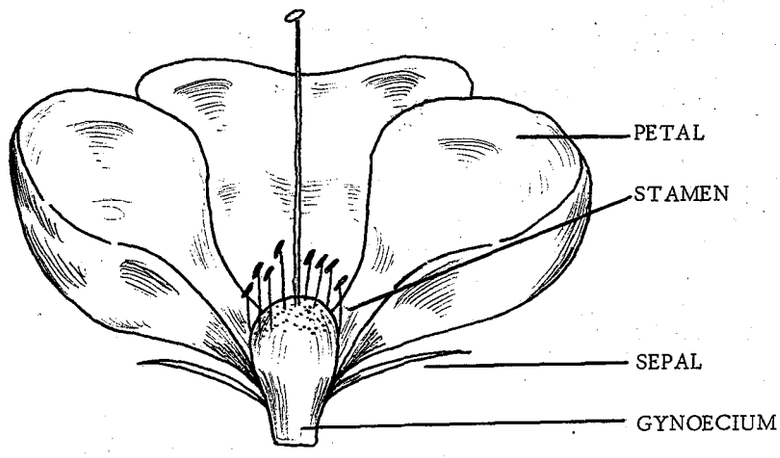
In the epidermis special openings occur. These are called stomata. (Plural : "Stomata"; singular : "stomate".) They may be opened or closed by the action of special cells adjacent to them called Guard Cells. When open, the stomata allow the interchange of gaseous material between the mesophyll and the atmosphere.

(d) The Flower

Function: The flower is the specialised part of the higher plants which carries the reproductive organs. Flowers have male and female parts and it is these which are responsible for the seed, which contains the embryo of a new plant.

The reproductive process will be studied later in the course.

Structure: Although the flowers of different plants vary considerably, all have the same basic parts. These are: (i) the sepals; (ii) the petals; (iii) the stamens; and (iv) the gynoecium. These are illustrated in the following diagram:-



(i) The sepals: The sepals enclose all the other flower parts in the bud. They are generally green in colour. Taken collectively, the sepals are known as the calyx. The function of the calyx is the protection of the other flower parts.

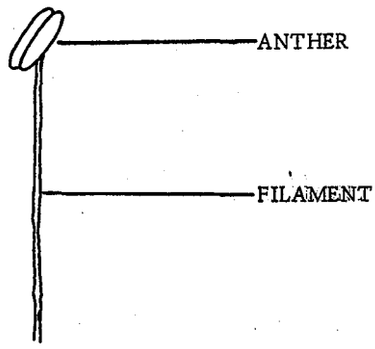
(ii) The petals: The petals are generally the scented and conspicuously coloured parts of the flower. They are found inside the sepals and are known collectively as the corolla. The petals are thought to attract bees and other insects which assist in the reproductive process.

MACROSCOPIC ANATOMY - PLANT MORPHOLOGY (continued)

(d) The Flower (continued)

(iii) The stamens: The stamens form a whorl inside the corolla. They are the male part of the flower. Each stamen consists of a slender stalk, or filament, on top of which is a pollen bearing organ called the anther. The whorl, or grouping, of the stamens is called the androecium.

The following diagram of a stamen illustrates the structure:-



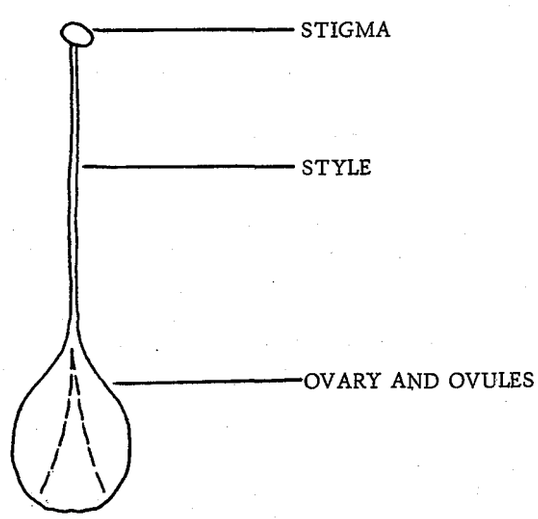
(iv) The Gynoecium: The gynoecium comprises the centre part of the flower. It is the female part and has three distinct parts:

(a) the expanded lower portion, called the ovary. This contains the ovules which will develop into seeds after fertilization.

(b) the style - which is a slender stalk supporting,

(c) the stigma - the organ which catches the pollen grains during reproduction.

The following is a diagram of a gynoecium:-



The gynoecium is also known as the "pistil" of the flower.

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CHAPTER III - PLANT NUTRITION AND PHYSIOLOGY

- THE VITAL LIFE PROCESSES OF PLANTS -

At this stage we have examined the way in which plants are put together and the basic parts which are characteristic of all plants.

The manner in which the plant maintains its life and produces the energy for its growth and reproduction will now be discussed. This is achieved by the means of four processes.

(a) Photosynthesis;

(b) Respiration;

(c) Transpiration; and

(d) Reproduction.

PHOTOSYNTHESIS

All living organisms, whether plant or animal, require food to live and grow. Food is made up of three things:-

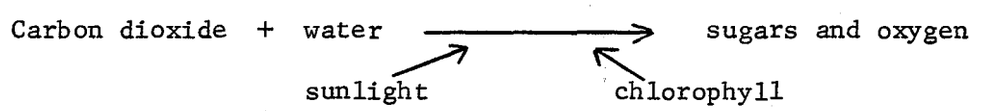
(i) organic "foodstuffs", such as carbohydrates, sugars, fats and proteins;

(ii) mineral elements, such as phosphorus and magnesium;

(iii) water.

The higher plants differ from all other living organisms in that they are able to make their own food. (Animals, in fact, are basically dependant upon the food made by plants for their nutritive requirements). Plants do this by the process of Photosynthesis, which is carried out in the green mesophyll cells of the leaf in the presence of sunlight.

Summary: The process by which the plant combines the basic elements from the soil and the air into usable plant food may be summarised as follows:



The Process: The four essential elements for photosynthesis are: (i) Carbon dioxide (CO_2), a gas which exists naturally in the atmosphere at a concentration of about 0.03%; (ii) water (H_2O) which is present in the soil and the atmosphere in the form of minute droplets; (iii) chlorophyll - the green coloured material in the mesophyll tissue of the leaf; and (iv) sunlight.

Water in the soil is absorbed by the root hairs and is then passed up through the xylem tissues of the stem, through the veins of the leaf and thence to the mesophyll cells. Carbon dioxide is drawn in from the atmosphere through the stomata of the leaf. There, in the presence of sunlight and chlorophyll, a complex chemical reaction takes place which converts the carbon dioxide and the water into the carbohydrates e.g. sugar and starch.

PHOTOSYNTHESIS (continued)

Another gas, oxygen (O_2) is formed as a by product, and is given off, via the stomata, to the atmosphere.

The Purpose of Photosynthesis: The sugars produced by the photosynthetic process can now be utilised by the plant as food. Some of these remain in the leaf and are used by the leaf tissues; the remainder finds its way into the phloem tissues of the leaf vein and from there is rapidly transported to all parts of the plant.

The Forester and Photosynthesis: There are several factors which affect the process of photosynthesis. These are: (i) the availability of water; (ii) the presence of chlorophyll; and (iii) the presence of sunlight. Carbon dioxide, the other essential participant in the process is generally present in the air at a constant concentration and rarely becomes a limiting factor.

The influence of the factors - water, chlorophyll and sunlight - on the photosynthesis of trees must be borne in mind by the forester. For instance, a tree which is ringbarked (either deliberately or accidentally) will die; it will die slowly if only the phloem tissues are severed, due to starvation of the roots (food supply from the crown is cut off), and it will die quickly if both the phloem and the xylem are cut, due to root starvation and crown drought (water supply from the roots cut off causing cessation of photosynthesis).

In the same way, damage to the leaves or crown of a tree will affect photosynthesis. The typical damaging agencies with which the forest tree has to contend are - fire, frost and insects.

Sunlight may be another limiting factor in the forest. When trees are grown too close together, there may not be sufficient sunlight for each member of the stand. This will cause reduced rates of food production and thus growth. (When this problem occurs it is generally overcome by thinning).

Since the prime concern of the forester is the growing of trees, any factor which will limit the rate of photosynthesis, and thus the rate of growth, should be eliminated by him from the forest.

RESPIRATION

The process by which plants produce their own food is called photosynthesis; the process by which this food is used up to provide the energy for the building up and repair of tissues and for the reproduction of the plant, is called Respiration.

Whereas photosynthesis occurs only in the green leaf cells of plants, respiration occurs in all living cells of all living organisms. The process we call breathing in animals is really only another name for respiration.

Summary: The process by which living cells respire (i.e. carry out respiration) may be summarised by the following equation:

Sugars + Oxygen $\longrightarrow$ carbon dioxide + water + energy

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essential mineral nutrients.

RESPIRATION (continued)

The Process: The sugars produced in the leaf by photosynthesis are transported to all living cells in the plant by way of the phloem tissue. Within these living cells they combine with oxygen from the air and certain mineral nutrients absorbed from the soil to ultimately produce carbon dioxide and water and release energy.

The actual process is an extremely complicated one and need not concern us here. The major points to remember are:-

1. Respiration provides the plant with the energy it requires for the building and maintenance of its cellular tissues.

2. Respiration requires the food products produced in photosynthesis. If photosynthesis is impeded, so will be respiration.

3. Respiration requires oxygen. This may be obtained from the atmosphere or, in the case of the roots, from air pockets which exist in the soil.

4. Respiration requires certain elements from the soil, called the essential plant nutrients. Examples of these are phosphorus, zinc, nitrogen and potassium.
(The essential plant nutrients are listed in Appendix III.)

The Forester and Respiration: The factors which effect the respiration of the plant are: (i) the availability of the food produced in photosynthesis; (ii) the availability of oxygen; and (iii) the availability of the essential plant nutrients.

If any of these factors are limiting (i.e., not present or not available to the plant) then the rate of respiration and thus the rate of growth of the plant or tree will be affected. The forester makes use of this knowledge in several ways:-

1. The addition of fertilizers such as superphosphate (which contains phosphorus) and zinc to pine forest soils which do not naturally contain sufficient of these nutrients.

2. The draining of water logged areas before planting trees on them. Soils which are water logged do not contain sufficient air in them to allow tree roots to respire.

3. The protection of forests from fire. Fire destroys the leaves of trees and thus removes their "food factory".

Nearly all forest practices, in fact, are aimed at creating conditions which will allow tree photosynthesis and respiration to proceed at the greatest rate, thus allowing trees to grow at their fastest rate.

The following table illustrates the major differences between the two processes.

RESPIRATION (continued)

	Photosynthesis	Respiration
Occurs in :	Only those cells of green plants which contain chlorophyll	All living cells
Raw Materials :	Water and carbon dioxide	Sugars, oxygen and essential plant nutrients
Time of occurrence :	Only when sunlight shines on the cell	Continuously, day and night.
Energy :	Stored by the process (Sunlight)	Released by the process
Products :	Oxygen and sugars	Carbon dioxide and water.

TRANSPIRATION

The third major process which occurs in plants is called transpiration. This may be summarised as the giving-off of excess moisture (water) from the plant to the atmosphere.

Under normal conditions, the plant takes up from the soil more water than it needs to maintain its photosynthetic process. The bulk of this water acts as a means of transporting the mineral plant nutrients up from the soil. These nutrients are deposited in the leaves and other living cells. The water which is not used in photosynthesis is then evaporated by the sun and lost through the stomata as water vapour.

Transpiration does occur from other cells of the plant, but a high proportion takes place from the cells of the leaf. Here, it has an important side effect - the evaporation of water helps to cool the leaf which would otherwise be dangerously overheated by its absorption of sun light energy.

The rate of Transpiration is increased by heat, wind and dry air and is lessened by cold and still or damp air.

THE STORAGE OF FOOD

In sunlight the plant usually produces more than twenty times the amount of food it is using at the moment. At other times, such as during the night, part of the winter or, say, after a hot fire, it consumes much more food than it can make.

All plants must therefore accumulate some food reserves to tide them over periods when photosynthesis cannot occur. Trees store food in:

THE STORAGE OF FOOD (continued)

(a) the leaves - generally a temporary storage place only;

(b) The xylem tissues of the younger heartwood and the older sapwood;

(c) the medullary rays of the younger heartwood; and

(d) the older roots.

Food storage is more important for deciduous trees (those which lose their leaves in winter) than in evergreen trees such as the West Australian Eucalypts, although with the latter it is an important safeguard against fire.

THE REPRODUCTION OF FLOWERING PLANTS

The fourth of the vital life processes we are to deal with is reproduction. This is the means of ensuring the continuance of plant life.

It will be recalled from the Anatomy lectures that the flowers of plants have both male and female parts; these are responsible for the reproductive process.

The Steps involved in the reproduction of flowering plants are as follows:

(a) The production of special reproductive cells.

These are the pollen grains in the anthers (male) and the ovules in the ovary (Female).

(b) Pollination of the flower. The pollen grains from one plant land on the stigma of another. They are carried there by wind or insects (such as bees). If conditions are right, the stigma will be sticky and the pollen grains will adhere to it. (This is called cross-pollination; when pollen from anthers of the same flower pollinate the stigma, it is called self-pollination.)

(c) Formation of the Pollen tube. A pollen grain which has been accepted by a stigma will send down a long tube (called a pollen tube) through the tissue of the style until it reaches the ovary at the base of the flower.

(d) Formation of the seed. After fertilisation, changes occur within the ovule - it enlarges, hardens and becomes a seed. The flower parts then drop off and with the enlarging of the ovary as a whole, the flower changes into a fruit. When the fruit later matures and then drops to the ground, the seed is thus released to the soil. From it, the young seedling can develop.

Vegetative Reproduction: The type of reproduction described above is called Sexual Reproduction. Plants may also reproduce vegetatively, that is, produce new plants without the processes described above being necessary. Types of vegetative reproduction are:

(i) coppice from stumps;

THE REPRODUCTION OF FLOWERING PLANTS (continued)

Vegetative Reproduction (continued)

(ii) suckers from roots; and

(iii) roots and shoots from cuttings.

Vegetative reproduction has some significance in forestry, as for instance, where the coppice from stumps is used as a means of regenerating a harvested forest crop.

This matter will be dealt with in more detail in the course on Silviculture.

GERMINATION

Anatomy of the Seed: Although the seeds formed in the ovaries of different types of plants vary considerably in size and shape, nearly all have the same basic anatomy. They consist of:

(i) The Seed Coat or "Testa": a tough skin, whose function is the protection of the delicate portions within the seed. The Testa may have a small hole at one end, called the micropyle.

(ii) The Embryo - the young plant: This has three parts - a small pointed root called the Radicle: the immature seed leaves, soon to become the cotyledons; and a small shoot bud lying between the seed leaves called the plumule. Thus the embryo, like older plants, consists of a root, shoot and leaves.

(iii) Stored Food: Food is stored within the seed to sustain the young plant until germination. This food may be stored in the cotyledons or occur as a white fleshy substance (called the endosperm), surrounding the embryo.

Germination of Seeds: Plants produce an enormous number of seeds during their life time. A mature Jarrah tree, for instance, may produce an average of 4,000 seeds each year.

The germination process begins when ripe seed (i.e. seed sufficiently mature to be capable of germination) falls to the ground and makes contact with the soil. The seed then enters a "resting stage" during which it lies dormant until conditions are suitable for germination (see next section).

When suitable conditions occur, the seed coat splits and is pushed aside by the growing radicle. The radicle is followed by the plumule which uncurls and pushes a shoot up through the soil until the surface is reached. This shoot is called an epicotyl.

On reaching the surface the seed leaves, or cotyledons, open and become green.

GERMINATION (continued)

Note: (i) the root radicle always appears first, pushing out from the testa at or about the micropyle.

(ii) the young shoot appears later and grows upwards toward the light and air.

Conditions Necessary for Germination: As a general rule, four conditions are necessary for seed germination. These are:

(i) Water: seeds will not germinate in completely dry soil.

(ii) Air: seeds contain living and growing cells and thus require oxygen for respiration; seeds planted too deeply in the soil, or in water-logged soil may fail to germinate through lack of oxygen.

(iii) Warmth: seeds require a certain degree of warmth before they will germinate; this factor is not of great importance in Western Australia, but can assume importance in countries where the soil freezes in winter.

(iv) Soil: soil is not essential for germination to occur, for seeds may germinate on moist logs, bark or moss. Soil is, however, essential for the successful establishment of seedlings, or regeneration as it is called by the forester.

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CHAPTER IV - PLANT TAXONOMY

- THE NAMING AND CLASSIFICATION OF PLANTS -

Even to the most casual observer, it is obvious that the earth is populated with a tremendous diversity of plant life. The forest areas, in particular, are rich with different shapes, sizes and types of plants.

For example, there are the mosses and lichens on rocks and old logs; the ferns, the fungi which inhabit the soil and rotten wood; the flowers and shrubs; and the trees themselves. All of these are members of the great Plant Kingdom.

In order to study this Kingdom properly, man has given each plant type a name of its own and has attempted to fit all the types into an orderly system of classification.

In this section of the course, we will look at how the names are given, how the Plant Kingdom is classified and how different members of it are identified.

BOTANICAL NOMENCLATURE: THE SCIENTIFIC NAMING OF PLANTS

Every known plant has a scientific name, and many have two names - a scientific name and a common name. An example is Jarrah - the common name for Eucalyptus marginata.

It is essential that each plant has a scientific name. This is for the following reasons:

(i) It is an accepted name throughout the world.

(ii) It is specific, in that it refers to only one type of plant.

(iii) Its relationship to the rest of the plant Kingdom is made clear.

The use of only the common names for plants has the following disadvantages:

(i) Restricted use - e.g. Water Bush, Blackboy.

(ii) the same name can apply to different plants - e.g. the Blackbutt of W.A. and the Blackbutt of N.S.W.

(iii) the name gives no indication of the plants' relationship with the rest of the Plant Kingdom as a whole.

The scientific name of a plant consists of two words, given in Latin (Latin was once the international language of science); for example, Eucalyptus marginata. The first word is the name of the Genus and the second is the name of the Species.

Let us now see what these terms mean.

THE UNITS OF CLASSIFICATION

The Species: It is customary to speak of each individual kind of plant as a species. The species is the basic unit of plant classification and may be defined as a group of plants with similar structure which are normally able to breed freely amongst themselves.

Thus all Jarrah trees are of the same species of the Plant Kingdom, Karri trees of a different species and Wandoo of another and so on.

Sometimes a species can contain a number of Varieties, or Races, which are slightly different types of the species growing in different geographic localities. An example is Pinus pinaster which has different races growing in France, Spain, Portugal and Corsica.

The Genus: To collect groups of similar species together is the next step in plant classification. The Genus (plural Genera) is the collective name for a group of species possessing certain common characteristics by which they are distinguishable from all other groups.

Thus Eucalyptus marginata (Jarrah) and Eucalyptus calophylla (Marri) are both species of the Genus Eucalyptus. Similarly Pinus radiata and Pinus pinaster are both species of the Genus Pinus.

The Family: The next step in plant classification is the family - this is a group of Genera which have certain common characteristics.

Other Categories: Going further into the classification, families are grouped into Orders; orders into Classes; and classes into Divisions (or Phyla).

These other categories do not concern us, but it is interesting to know that this is the system used by scientists in the classification of plants.

Classification of Some W.A. Trees

Family	Genus	Species	Common Name
Myrtaceae	Eucalyptus	diversicolor	Karri
Pinaceae	Pinus	radiata	Monterey Pine
Casuarinaceae	Casuarina	fraseriana	Sheoak
Myrtaceae	Agonis	flexuosa	Peppermint
Santalaceae	Santalum	cygnorium	Sandalwood
Cupressaceae	Callitrus	robusta	Rottnest Island Pine

In writing the names of plants, it is important to note that:-

(i) The Genus name is always written with a capital letter.

(ii) The Species name is nearly always written with a small letter (there are one or two exceptions in the Plant Kingdom).

(iii) The common name is generally written with a capital letter (but need not be necessarily).

For example: Eucalyptus patens (Blackbutt).

THE CLASSIFICATION OF THE PLANT KINGDOM

The entire plant kingdom is classified into several broad categories. These can be called: (1) the Algae; (2) the Fungi; (3) the Bacteria; (4) the Mosses; (5) the Ferns; and (6) the Seed Plants.

As foresters, we are primarily concerned with the Seed Plants, the category within which the timber trees of the world occur - but as other types of plants are all found in our forests, it is as well to look briefly at them.

1. The Algae

The algae are very primitive members of the plant kingdom. Many are unicellular - i.e., the entire plant consists of only one cell - and all are aquatic, living exclusively in the sea or fresh water. Most of the Seaweeds, River weeds and Scum belong to the Algae group.

They are of little significance in forestry.

2. The Fungi

The fungi are an important group of plants to the forester, because they are responsible for the Rots which occur in timber and standing trees and for many plant diseases.

Fungi (and Bacteria) are the only members of the Plant Kingdom which do not contain chlorophyll and thus cannot produce their own food material. This they obtain from other living organisms, or from the organic remains of dead organisms.

The Fungi are studied in more detail in the course on forest pathology.

3. The Bacteria

Bacteria are extremely simple and minute plant organisms. They may live in the soil, the air or in water. However, they have a great influence on the life of man.

The following are some examples of the way in which Bacteria effect the life of man:-

(i) they cause diseases in both plants and animals;

(ii) they are responsible for the spoiling of foods;

(iii) they improve soil fertility, by "fixing" nitrogen from the air into the soil and by assisting in the release of plant nutrients from organic remains to the soil.

(iv) they assist in the fermentation of certain liquids into beers, wines and spirits.

The study of Bacteria is called Bacteriology. It is an important science in the modern world.

THE CLASSIFICATION OF THE PLANT KINGDOM (continued)

4. The Mosses

The Mosses are a more highly developed form of plant than the Fungi, Algae or Bacteria. They are usually found in areas of high rainfall or humidity, forming colonies on soil, rocks or logs.

The Mosses have leaves and stems, but neither roots nor a true vascular system. They absorb moisture through their leaves.

5. The Ferns

These types of plants have stems, leaves and roots but do not have flowers or seeds. They reproduce by seed-like structures called spores which are formed on the underside of the leaf.

The Bracken Fern (Pteridium aquilinum), which is found throughout the forest areas of the south west, is typical of the Fern Group.

6. The Seed Plants

The plants which reproduce by means of a seed are known as the "Higher Plants". There are over 250,000 known species in this category.

There are two great divisions of the higher plants. These are:

(i) The Gymnosperms: these are characterised by the fact that the ovule is open at the time of pollination, and is formed in a cone - not a flower. The Conifers ("Soft-woods") are found in the gymnosperm group.

(ii) The Angiosperms: these are characterised by the ovules being enclosed in the ovary of a flower at the time of pollination. They are further sub-divided into two categories:

(a) The Monocotyledons: plants which have one seed leaf (or "Cotyledon") at the time of germination;

(b) The Dicotyledons: plants which have two seed leaves at the time of germination.

THE IDENTIFICATION OF PLANTS

The two main ways of identifying (i.e., finding out the names of) plants are:-

(i) To make a collection of plant specimens, mount them on paper and then either check them against named specimens or have them identified by a Botanist.

THE IDENTIFICATION OF PLANTS (continued)

(ii) To use a plant key. This is the most practical way for the practicing forester. A practical course will be held in class to demonstrate the method.

It is essential that the forester knows the names of the common plant species of the area in which he is working.

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CHAPTER V - DENDROLOGY

- THE FOREST TREES OF WEST AUSTRALIA -

Dendrology is the taxonomic study of trees and of the methods of identifying different tree species. The study of dendrology is an essential part of the background training of the forester.

The important timber-producing trees of Western Australia fall into two groups: (i) the Eucalypts, or so-called "Gum Trees", which are indigenous to the State, and (ii) the Conifers, the most important of which were originally introduced to this State from other countries.

In this section of the course, the general characteristics of the Eucalypts and of the Conifers will be examined, and the principle forest trees of W.A. discussed.

Before this may be done, however, it is desirable to look first at the general features used in the identification of trees.

FEATURES USED IN THE IDENTIFICATION OF TREES

There are six major features used in the identification of a tree species. These are:

1. Habitat: The habitat is the place where the tree may be found growing naturally. Many trees have a restricted habitat, and this may often provide a clue to identification. For instance, Flooded Gum (E.rudis) is a tree which (in forest areas) is found almost exclusively on the banks of rivers and creeks, or on soils with a high moisture content.

2. Habit: The habit of a tree is its general appearance. The height of a tree, the crown shape and colour, the length of the bole compared with the total height and the straightness of the branches are all features which can be used in describing the habit of a tree for the purpose of identification.

3. Bark: Different tree species may differ in the colour, texture and structure of their bark. Bark is one of the most useful aids in the identification of many W.A. trees (e.g., Jarrah and Wandoo).

4. Leaves: The shape, size, colour and venation of leaves are important features for use in the identification of a tree species. In the case of the Eucalypts, the juvenile and the adult leaves should both be examined.

5. Reproductive Organs: The flowers, buds, fruits or cones, all take distinctive shapes in different tree species, and are most useful features for identification.

6. Wood: The colour, density, hardness and durability as well as the character of the ash when burnt, are all features used in the identification of different species.

Identification of trees, and particularly the Eucalypts, is often far from a simple task and a single characteristic is rarely sufficient for the purpose. A positive identification can generally result only from a careful consideration of a number of the features possessed by an individual.

THE BOTANICAL FEATURES OF THE EUCALYPTS

The Family Myrtaceae: The Genus Eucalyptus is a member of the Family Myrtaceae. This family has three general botanical characteristics: (i) the presence of oil glands in the leaves; (ii) four or five petals or sepals in each flower; and (iii) multiple stamens, often united into bundles.

Apart from the Genus Eucalyptus, the Family Myrtaceae contains several other Genera whose species are familiar to Australians. Some of these are:-

(a) Tree Forms:

Genus Melaleuca	-	the Paperbarks.
" Agonis	-	the Peppermint & Native Cedar.

and three important Eastern States Genera:

Genus Angophora	-	Rough Barked Apple
" Tristania	-	Brush Box
" Syncarpia	-	Turpentine.

(b) Non-tree Forms:

Genus Callistemon)		
)	-	the Bottle Brushes
" Beaufortia)		
" Leptospermum	-	the Ti-trees
" Chamalaucium	-	Geraldton Wax

The Genus Eucalyptus: The Genus Eucalyptus is by far the most economically important member of the Myrtaceae family; it is in fact the most important Genus of Australian forest trees. Its members dominate 95 per cent of the forest area of Australia and spread out over much of the remainder of the country. Different species of the Genus Eucalyptus can be found equally well adapted to the dry inland areas of W.A., to the temperate rain forests of Tasmania and to the alps of Victoria.

With such a wide distribution, it is natural to expect that there will be a wide diversity of characteristics within the Genus. This is so.

In the following sections, the botanical features of the Genus Eucalyptus will be examined.

Habitat: Eucalypts are found in nearly all parts of Australia where trees will grow. There are over six hundred known species in the Genus, approximately one hundred and fifty of which occur in Western Australia. The great majority of West Australian Eucalypts occur in the south west and Goldfields regions of the State.

Habit: The Eucalypts are divided, according to their habit, into four categories - trees; shrubs; mallees and marlocks.

(a) Trees: trees possess a well-developed trunk or bole, which is more than 20 ft. high.

THE BOTANICAL FEATURES OF THE EUCALYPTS (continued)

Habit (continued)

(b) Shrubs: shrubs have no single bole; several short stems branch from beneath, or just at, ground level; less than 30 ft. high.

(c) Mallees: a dwarf form of eucalypt: have several stems, usually less than 30 ft. high, arising from a bulbous, woody rootstock embedded in the upper layers of the soil.

(d) Marlocks: these are similar to Mallees in appearance, but have a smaller, reduced rootstock. They inhabit the sand plain areas of the inland.

Bark: The bark of the Eucalypts is a highly variable characteristic. There are two general categories: (i) the Rough Barked eucalypts, and (ii) the smooth (or "Gum") barked eucalypts.

Examples of the rough barked eucalypts are: Jarrah which has a fibrous, stringy bark; and Marri, which has a flaky, tesselated bark.

Examples of the smooth barked eucalypts are Karri and Wandoo. This type of tree tends to shed the outer layer of its bark annually.

Rough barked eucalypts are nearly always more fire-resistant than smooth-barked trees.

Leaves: The size, shape, colour and venation of Eucalypt leaves varies from species to species, but all have several common features. Leaf shape tends to be either lanceolate (lance shaped) or ovate (egg shaped). The venation consists of a midrib connected by fine secondary veins to a more or less distinct intramarginal vein.

The leaves are generally stalked and alternate in the adult form, but can be opposite and sessile (no petiole), for at least a few pairs, on seedlings and juvenile shoots.

Buds and Fruits: The Eucalypts bud is characterised by the presence of an operculum (or cap) made up of fused petals. The operculum covers the bud until it is forced off by the expanding stamens of the flower. The presence of the operculum is the most characteristic feature of the Eucalypts.

Fruits can take many distinctive forms. The fruits of Jarrah and Marri illustrate differences which occur (see page 34 of "Forestry in W.A.").

Wood: The Eucalypts display a considerable range of wood characteristics. The wood properties of the local species will be covered later in another course.

THE BOTANICAL FEATURES OF THE CONIFERS

The Order Coniferales: The "softwoods" of world commerce all occur within an order of the Gymnosperms called the Order Conferales. The major characteristic of the Gymnosperms is that the seeds are not enclosed within an ovary, but are carried naked on scales. (A scale is a reduced leaf.) In the Conferales, these scales are aggregated together to form a fruit called a Cone.

The Order Coniferales is made up of six families, the genera of which all contain timber-producing species.

The members of the Coniferales which either occur naturally in Western Australia or have been introduced from outside countries, are as follows:-

1. The true pines: of the Family Pinaceae (e.g. Pinus radiata, introduced to W.A. from California).

2. The Cypress Pines: of the Family Cupressaceae. (e.g. Rottnest Island Pine; Goldfields Pine.)

3. The Araucarias: of the Family Araucariaceae. (e.g. Norfolk Island Pine; Hoop Pine.)

Identification and Classification: With one or two exceptions, the features used in the identification and classification of the Conifers are the same as those used for other trees. The features used are:-

Habit: The general shape, size and form of the tree; all the important conifers grown in W.A. attain the habit of true tree.

Bark: Bark type varies with different species of the conifers and can be a means of identification. There are not such marked differences in bark types in the conifers as there are in the Eucalypts, however, and the feature is thus correspondingly less useful.

Leaves: The leaf types of the conifers vary from one group to another. In the pines, leaves take the form of needles. These needles occur in bundles and the number of needles in the bundle is a principal feature in dividing the pines into two large groups: (i) the five needle pines, and (ii) others.

The stiffness, colour and length of the needles are characteristic of different species, and are features which can be used for identification.

Resting Bud: When a conifer finishes growing for a season, it forms a Resting Bud at each branch growing tip. This Resting Bud can take several typical forms and can also be a useful feature for identification (e.g. Pinus canariensis).

Flowers and Fruits: The conifers generally have male and female flowers rather than male and female parts of the same flower as do the Angiosperms. The male flowers (the pollen producers) are small, brown temporary structures, usually found near or at the tip of the branch. The female flower consists of a number of scales grouped together to form a cone. The size, shape and markings on the cone and of the individual scales vary in different species and are invaluable features for identification.

THE BOTANICAL FEATURES OF THE CONIFERS (continued)

Wood: The wood of the conifers is generally pale in colour and without conspicuous medullary rays. The structure and properties of the wood will be covered later in another course.

THE PRINCIPLE FOREST TREES OF WESTERN AUSTRALIA

Indigenous Species: The major indigenous forest tree species of Western Australia are:-

Eucalyptus	marginata	-	Jarrah
"	diversicolor	-	Karri
"	redunca variety elata	-	Wandoo
"	patens	-	Blackbutt
"	calophylla	-	Marri
"	gomphocephala	-	Tuart
"	Jacksoni	-	Red Tingle
"	accedens	-	Powder Bark Wandoo
"	salmonophloia	-	Salmon Gum
"	astringens	-	Brown Mallett

Introduced Species: It will be noted that all the trees listed above are "hardwoods". There are no softwoods of economic importance occuring naturally in Western Australia. This deficit is made up by the planting of Introduced Species, or "Exotics".

Of the exotics occuring in Western Australia, the two most important are:-

Pinus radiata - the Monterey Pine from California, and

Pinus pinaster - the Maritime Pine from Portugal and Spain.

Other exotic tree species found planted in Western Australia, either as trial species or for ornamental purposes include:-

Softwoods:

Sequoia sempervirens	-	Californian Redwood
Pseudotsuga taxifolia	-	Douglas Fir (Oregon)
Various Pinus Species	-	canariensis, taeda, etc.
Araucaria excelsa	-	Norfolk Island Pine
Agathis australis	-	Kauri Pine

THE PRINCIPLE FOREST TREES OF WESTERN AUSTRALIA (continued)

Hardwoods: (planted mainly as ornamental)

Salix babilonica	-	Weeping Willow
Quercus species	-	Oak
Platanus "	-	Plane Trees
Fraxinus "	-	Ash Trees.

Other Forest Trees: Apart from the principle hardwood timber trees mentioned, there are a multitude of other tree species occuring naturally in W.A. For a complete list of the Eucalypts of Western Australia, see pages 164 and 165 of "Forestry in W.A.".

Some of the common non-Eucalypt tree species which grow in the forest areas of the State are:-

Agonis flexuosa	-	Peppermint
" juniperiana	-	Warren River Cedar
Banksia grandis	-	the Bull Banksia
" verticillata	-	River Banksia
Casuarina fraseriana	-	Sheoak
" decussata	-	Karri Oak.

THE TIMBER PRODUCING TREES OF WESTERN AUSTRALIA

There are ten major timber producing trees of Western Australia. These are: Jarrah; Karri; Wandoo; Blackbutt; Marri; Tuart; Red Tingle; Powder Bark Wandoo; Pinus radiata and Pinus pinaster.

The properties and characteristics of each of these trees can be found in "A Key to the Eucalypts" by Blakely.

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APPENDIX I - PROJECTS

To help in gaining a proper understanding of Botany, and in particular the forest Botany of W.A., it is desirable that each student carry out a number of practical assignments. A suggested list of projects appears below.

Anatomy:

1. Collect several small plants from the forest floor. Examine, describe and illustrate the morphology of their stems, roots and leaves.

2. Examine and illustrate the parts of several common flowers.

Taxonomy:

3. Collect, press, mount and write descriptive notes on a specimen from each of the following groups of the plant Kingdom: the Algae, the Mosses, the Ferns, the Flowering Plants.

4. With the assistance of the instructor, identify a number of common W.A. wildflowers using Blackalls "Key to the Wildflowers of W.A."

Dendrology:

5. Make a Dendrology collection of:-

   (i) specimens of the leaves, buds, bark, fruits and wood of the following Jarrah Forest species:

   Jarrah
   Marri
   Blackbutt
   Flooded Gum
   Bullich
   Wandoo
   Bull Banksia
   River Banksia
   Sheoak.

   (ii) Specimens of the needles, Resting Bud, cones, bark and wood of:

   Pinus radiata
   Pinus pinasta.

APPENDIX I - PROJECTS (continued)

6. When in the Karri forest area, compile a dendrology collection of the following common Karri Forest species:

Karri
Red Tingle
Yellow Tingle
Red Flowering Gum
Peppermint
Warren River Cedar
Karri Oak
Karri Wattle
Hazel and other Fire Weeds.

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APPENDIX II - SUGGESTED READING

These notes have been essentially introductory in nature and the reader may find that he wishes to pursue particular aspects of the course in greater detail.

The following are recommended as being useful publications (all are available from the Forests Department Library):

1. "Forestry in W.A.", Chapters 2 and 3. (Should be an essential follow-up to these notes).

2. "The Forest Trees of Australia", Forestry and Timber Bureau Publication.

3. "Botany - A Junior Book for Schools" by R.H.Yapp.

4. "Botany - An Introduction to Plant Science" by Robbins, Weir and Stocking.

5. "Botany of the Living Plant" by F.O.Bower (Divisions I and II very useful general reading).

6. "The Language of Botany" by C.N.Debenham. (Contains an extremely comprehensive glossary and some useful diagrams.)

7. "The Anatomy of the Seed Plants" by K.Esau (A more advanced text).

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APPENDIX III - THE ESSENTIAL PLANT NUTRIENTS

The following elements are required by the plant for healthy life and growth:

	Name	Chemical Symbol
The Major Elements:	Calcium	Ca
	Carbon	C
	Hydrogen	H
	Oxygen	O
	Potassium	K
	Nitrogen	N
	Sulphur	S
	Phosphorus	P
	Magnesium	Mg
	Iron	Fe
The Minor Elements:	Boron	Bo
	Manganese	Mn
	Zinc	Zi
	Copper	Cu
	Molybdenum	Mo

With the exception of Hydrogen (which comes from water) and oxygen, carbon and nitrogen (which come from the air), all of the essential elements are derived from the rock minerals of the soil. The subject of plant nutrition and the origin, uses and importance of the various plant nutrients is covered in greater detail in the courses on "Silviculture" and "Forest Soils".

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APPENDIX IV - SHORT GLOSSARY OF BOTANICAL TERMS

ALTERNATE:	(Leaves) - a regular arrangement of leaves along a stem in which the adjacent leaves are neither opposite nor whorled.
ANNUAL RING:	A layer of xylem and phloem produced during one growth season.
ANTHER:	The pollen bearing portion of a stamen.
APICAL MERISTEM:	A group of meristematic cells at the tip of a root or shoot.
BARK:	All tissues of the stem formed outside the cambium.
CAMBIUM:	The stem meristem; consists of a narrow sheath of dividing cells. Responsible for the growth in girth of a tree.
CALYX:	The outer whorl of floral leaves, composed of free or united sepals.
CAPSULE:	A dry fruit (Eucalypts) which opens to release the seed.
CELL:	The structural and physiological unit of the living organism. Consists of a cell wall and protoplasm.
CELLULOSE:	A complex chemical substance; is the chief component of plant cell wall.
CELL WALL:	A more or less rigid membrane enclosing the protoplasm of the cell.
CHLOROPHYLL:	The green colouring material in plants. Necessary for Photosynthesis.
CONE:	The woody fruit of a conifer - e.g. pine cone.
COROLLA:	The second whorl of floral leaves, consisting of free or united petals.
EPIDERMIS:	The tough outer layer of cells which covers certain parts of the plant - e.g. root, leaf, etc.
FASCICLE:	A bundle - in pines, the bundle containing the needles.
FIBRE:	A long, thick-walled cell.
FIBROUS ROOT SYSTEM:	A root system composed of many roots, approximately equal in length and thickness.
FILAMENT:	The stalk of a stamen.
FRUIT:	The protective, fleshy tissue surrounding the seed; develops from the ovary of the flower.

APPENDIX IV - SHORT GLOSSARY OF BOTANICAL TERMS (continued)

GENUS:	The collective name of a group of species possessing certain characteristics by which they are distinguished from all others.
GROWTH:	Increase in size by cell division and/or cell expansion.
GUARD CELL:	The two cells which open and shut the stomata.
HARDWOOD:	Wood produced by dicotyledonous trees.
HEARTWOOD:	The inner layers of wood within the growing tree; consists of dead xylem tissue.
INCREMENT:	Growth.
INFLORESCENCE:	The flower bearing portion of the plant, including the flowers themselves.
KINO:	A dark reddish "gum" developed at the cambial region of the tree as a result of injury.
LIGNIN:	A complex chemical substance which is associated with cellulose in the walls of many cells of woody plants.
MEDULLARY RAY:	Cells running radially across the stem; responsible for radial food transport and for food storage.
MERISTEM:	Tissue concerned with the formation of new cells by division.
MESOPHYLL:	The photosynthetic material of the leaf; either Pallisade or Spongy.
OPERCULUM:	The lid, or cap, made up of fused petals, which covers the stamens in the buds of Eucalypts.
OVARY:	The part of the flower which contains the ovule or ovules. The immature fruit.
OVULE:	The structure which contains the egg cell, which after fertilization becomes the seed.
PETAL:	One unit of a corolla.
PETIOLE:	The stalk of a leaf.
PHLOEM:	The principal food conducting tissue of the vascular plants.
PITH:	The tissue in the centre of the stem or root.
PHOTOSYNTHESIS:	The process occuring within the mesophyll cells of the leaf whereby plant foods are synthesised out of carbon dioxide and water.

APPENDIX IV - SHORT GLOSSARY OF BOTANICAL TERMS (continued)

PROTOPLASM:	The living matter of the cell; is surrounded by the cell wall and contains the nucleus and the cytoplasm.
RESPIRATION:	The process occurring within the living cells of all parts of the plant whereby the foods produced in photosynthesis are utilised. Energy is released.
ROOT CAP:	A thimble-like mass of cells covering the apical meristem of the root.
ROOT HAIR:	A simple structure of the root epidermis which is responsible for the adsorption of soil solution.
SAPWOOD:	Wood that in the living tree contains live conducting cells and reserve food.
SCALES:	Modified leaves within an inflorescence.
SESSILE:	Without a stalk.
SOFTWOOD:	Wood produced by conifer trees.
STOMATE:	Pore in the epidermis of the leaf.
TAP ROOT SYSTEM:	A root system based on a taproot.
VACUOLE:	Cavity within the cytoplasm filled with a watery fluid, the cell sap.
VASCULAR BUNDLES:	The strands of tissue responsible for the transport of water and food within the plant. Composed of xylem and phloem.
XYLEM:	The principle water conducting tissue in plants. Dead xylem tissue (heartwood) functions as supporting tissue in woody plants.

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